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Declaration

I, Michihiko Matsuba, President of Fukuyama Sangyo Honyaku Center, Ltd., of 16-3, 2-chome, Nogami-cho, Fukuyama, Japan, do solemnly and sincerely declare that I understand well both the Japanese and English languages and that the attached document in English is a full and faithful translation, of the copy of Japanese Unexamined Patent No. Hei-7-191247 laid open on July 28, 1995.

M. Matsuba

Michihiko Matsuba

Fukuyama Sangyo Honyaku Center, Ltd.

LENS HOLDING STRUCTURAL BODY

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Applicant: CHINON Industries Inc.

Inventor: Hiroshi HODAKA, et al.

Patent Attorney: Noboru KABASAWA, et al.

SPECIFICATION

[TITLE OF THE INVENTION]

Lens holding structural body

[ABSTRACT]

[Object] To provide a lens holding structural body that is capable of easily rearranging lenses and that is capable of preventing the occurrence of distortion by absorbing deformation caused by heat without degrading the surface accuracy of the lenses.

[Solution means] A lens 11 is held in a radial direction by a retaining ring 12 fitted to the outer periphery of the lens 11 and by a holding frame 13 fitted to the outer periphery of the lens 11. A collar part 11b of the lens 11 fitted to the

retaining ring 12 is clamped from above and below by a flange part 13a of the holding frame 13 and by an annular lens retainer 14 screwed to the upper part of the holding frame 13. Deformation with respect to the holding frame 13 is generated in the radial direction of the lens 11 by a difference in the coefficient of linear expansion with the holding frame 13 when the lens is used in an environment where a temperature change is severe. The retaining ring 12 having nearly the same coefficient of linear expansion as the coefficient of linear expansion of the lens 11 generates elastic deformation by the effect of a first gap 16 and first joint part 17 formed between the outer periphery of the lens 11 and the retaining ring 12 and by the effect of a second joint part 20 and second gap 21 formed between the retaining ring 12 and the holding frame 13, thereby absorbing the deformation of the lens 11.

[WHAT IS CLAIMED IS;]

[Claim 1] A lens holding structural body comprising a lens, a retaining ring that is annularly formed and that holds an outer periphery of the lens by its inner periphery, and a holding frame that is annularly formed and that holds the retaining ring by its inner periphery, the lens holding structural body wherein:

a plurality of first gaps that are formed with

predetermined lengths along circumferential directions of these and that are disposed at substantially equal intervals, and

first joint parts that are joined to an opposite side at parts other than these first gaps,

the first gaps and the first joint parts being between the outer periphery of the lens and the inner periphery of the retaining ring; and

second joint parts that are disposed within ranges respectively corresponding to the first gaps and that are mutually joined to an opposite side at parts having lengths in circumferential directions smaller than the first gaps, and

second gaps disposed at parts other than the joint parts,

the second joint parts and the second gaps being between the outer periphery of the retaining ring and the inner periphery of the holding frame.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Field of the Invention] The present invention relates to a lens holding structural body that can be used in the vicinity of a high heat source or in an environment where a temperature change is severe.

[0002]

[Prior Arts] Recently, many plastic lenses have come to be used in optical systems. In a case in which the plastic lens is used in an optical system, if the lens is expanded by heat, distortion will occur in the lens, and optical properties will be impaired because of a difference in the coefficient of linear thermal expansion between the lens and a fixing frame that fixes the lens. This tendency is pronounced especially when it is used in a projector having a high heat source or is used in an environment where a temperature change is severe.

[0003] Conventionally, in response to the aforementioned problem caused by the fact that the lens is expanded and shrunk by heat, structures have been employed as disclosed in Japanese Unexamined Patent Publication No. Sho-61-46918, Japanese Unexamined Patent Publication No. Sho-62-23513, and Japanese Unexamined Patent Publication No. Sho-62-32017 in each of which an elastic body, by which the thermal deformation of a lens is absorbed, is interposed between a lens and a holding frame that holds the lens, or as disclosed in Japanese Unexamined Utility Model No. Hei-5-50402 in which a notched concave part is formed in the outer peripheral surface of a plastic lens itself along the outer-periphery direction of the plastic lens, and a circularly arcuate groove hole is formed in a part in the vicinity of the outer periphery of the lens, and the hole

is cut along the outer periphery and penetrates in an optical-axis direction, so that the thermal deformation of the lens is absorbed by these notched concave part and circularly arcuate groove hole.

[0004] However, since the device in which the elastic body is interposed between the lens and the holding frame has operational difficulty in injecting a rubber-based adhesive serving as the elastic body into a narrow space between the lens and the holding frame, many man-hours are required. Additionally, after the lens is firmly joined to the holding frame with the adhesive, the lens cannot be detached from the holding frame, and, if a lens defect or the like occurs, it becomes difficult to replace it with another lens.

[0005] Additionally, in which a device in a notched concave part or a circularly arcuate groove hole is formed in a plastic lens itself, there is a fear that a crack will be generated in the groove hole part by a weld, or the like, formed when the lens is molded, and molding becomes difficult. Additionally, if the notched concave part, the groove hole, etc., are uneven, distortion will occur in the surface of the lens, and the surface accuracy of the lens will be lowered. Additionally, in a case in which the groove hole is subjected to additional processing, processing expenses arise

separately, and costs rise.

[0006]

[Problems to be Solved by the Invention] As described above, conventional devices have difficulty in rearranging lenses when an elastic body is used, and have difficulty in molding lenses when notched concave parts or groove holes are formed, and, disadvantageously, there is a fear that a decrease in the surface accuracy of lenses will occur.

[0007] An object of the present invention is to provide a lens holding structural body that is capable of easily rearranging lenses and that is capable of preventing the occurrence of distortion by absorbing deformation caused by heat without degrading the surface accuracy of the lenses.

[0008]

[Means for Solving the Problems] The present invention is a lens holding structural body comprising a lens, a retaining ring that is annularly formed and that holds an outer periphery of the lens by its inner periphery, and a holding frame that is annularly formed and that holds the retaining ring by its inner periphery, the lens holding structural body including: a plurality of first gaps that are formed with predetermined lengths along circumferential directions of these and that are disposed at substantially equal intervals, and first joint

parts that are joined to an opposite side at parts other than these first gaps, the first gaps and the first joint parts being between the outer periphery of the lens and the inner periphery of the retaining ring; and second joint parts that are disposed within ranges respectively corresponding to the first gaps and that are mutually joined to an opposite side at parts having lengths in circumferential directions smaller than the first gaps, and second gaps disposed at parts other than the joint parts, the second joint parts and the second gaps being between the outer periphery of the retaining ring and the inner periphery of the holding frame.

[0009]

[Action] In the present invention, a first gap and a first joint part, which are formed between the outer periphery of a lens and a retaining ring, and a second joint part and a second gap, which are formed between the outer periphery of a retaining ring and the inner periphery of a holding frame, absorb deformation caused when the lens is expanded and shrunk because of heat by elasticity, and therefore the distortion of the lens can be prevented, and stable lens performance can be obtained.

[0010]

[Preferred Embodiment of the Invention] An embodiment of a lens holding structural body of the present invention will be

hereinafter described with reference to the drawings.

[0011] In Fig. 1, 11 designates a lens made of a plastic material. The lens 11 is made up of a lens body part 11a that has a predetermined curvature and a flat collar part 11b formed at the edge of the lens body part 11a.

[0012] The inner periphery of an annular retaining ring 12 made of a plastic material is fitted to the outer periphery of the lens 11. The retaining ring 12 has the coefficient of linear expansion equal to that of the lens 11 and holds the lens 11.

[0013] Further, an annular holding frame 13 is similarly fitted to the outer periphery of the retaining ring 12. The holding ring 13 is formed with a material smaller in the coefficient of linear expansion than the lens 11 and the retaining ring 12, and holds the outer periphery of the retaining ring 12. As shown in Fig. 2, a horizontal flange part 13a is provided at the inner periphery of the lower part of the holding frame 13. The undersurface of the collar part 11b of the lens 11 to which the retaining ring 12 is integrally attached is supported by the upper surface of the flange part 13a. A threaded groove 13b is formed at the inner periphery of the upper part of the holding frame 13, and the outer periphery of an annular lens retainer 14 is screwed thereto. Further, as shown in Fig. 2, the lens retainer 14 clamps the collar part

11b of the lens 11 from above and below together with the flange part 13a, and holds the lens 11 in a thrust direction along an optical axis of the lens 11.

[0014] Herein, between the outer periphery of the lens 11 and the inner periphery of the retaining ring 12, a plurality of first intervals 16 each having a predetermined length along the circumferential direction of the lens 11 and of the retaining ring 12 are disposed at almost equal intervals. That is, three first gaps 16 are disposed so as to make 120° between their centers in the lengthwise direction. Parts other than the first gaps 16 serve as first joint parts 17 to an opposite side. Herein, the first gap 16 and the first joint part 17 are generated by forming three concave parts 19, each of which has a predetermined length, on the outer peripheral surface of the collar part 11a of the lens 11.

[0015] A plurality of second joint parts 20, e.g., three second joint parts 20 to an opposite side are disposed between the outer periphery of the retaining ring 12 and the inner periphery of the holding frame 13. Each of the second joint parts 20 is placed at a center part in a lengthwise direction within the range corresponding to the first gap 16, and has a smaller length in the circumferential direction than a length in the circumferential direction of the first gap 16. Parts other

than the second joint parts 20 serve as second gaps 21, of course. The second joint parts 20 are generated by forming the outer peripheral surface of the retaining ring 12 so that three parts protrude from the outer peripheral surface thereof at intervals of 120°.

[0016] In the aforementioned structure, since the lens 11 is held in the radial direction by the retaining ring 12 fitted to the outer periphery of the lens 11 and by the holding frame 13 fitted to the outer periphery of the lens 11 in a state in which the lens 11 is attached thereto, the lens 11 neither deviates in the radial direction nor jounces, and can be held and fixed in an accurate positional relationship. Additionally, since the collar part 11b of the lens 11 to which the retaining ring 12 is fitted is clamped from above and below by the flange part 13a of the holding frame 13 and by the annular lens retainer 14 screwed to the upper part of the holding frame 13 as described above, the lens 11 is reliably held also in the thrust direction along the optical axis of the lens 11 and can be accurately positioned and fixed without generating a saccadic movement or the like.

[0017] Further, when it is used in an environment, such as a projector having a high heat source, where a temperature change is severe, deformation to the holding frame 13 occurs in the

radial direction of the lens 11 because of a difference in the coefficient of linear expansion with the holding frame 13. Concerning this deformation, the retaining ring 12 that has almost the same coefficient of linear expansion as the lens 11 causes elastic deformation by the effect of the first joint part 17 and the first gap 16 formed between the outer periphery of the lens 11 and the retaining ring 12 and by the effect of the second gap 21 and the second joint part 20 formed between the retaining ring 12 and the holding frame 13, and thus the deformation of the lens 11 is absorbed. Therefore, the lens 11 is never distorted by the deformation.

[0018] Herein, the elastic deformation of the retaining ring 12 described above is caused as follows.

[0019] First, when the lens 11 is expanded, its stress acts on the joint part 17 between the lens 11 and the retaining ring 12. The retaining ring 12 is joined to the holding frame 13 by the second joint part 20, and parts other than this are used as the second gaps 21. The second gap 21 is partially overlapped with the first gap 16 between the lens 11 and the retaining ring 12, and the elastic deformation can be caused in this overlapped part. For example, when the lens 11 is expanded, stress caused by this expansion is absorbed by allowing the overlapped part to be elastically deformed in the

direction of the second gap 21 with the second joint part 20 as a fulcrum.

[0020] Thus, since the expansion and shrinkage caused by the heat of the lens 11 can be absorbed, optical performance can be stabilized. As a result, a plastic lens becomes applicable in the temperature in which its application has been conventionally difficult, and a device having the lens 11 can be reduced in cost and in weight.

[0021] Similarly, the range of use of the plastic lens is enlarged, and it becomes applicable to a large-sized, special lens having a high heat source, especially to a small-lot, high-valued added lens, such as a projection lens used for a projector. Further, since conventional assembling techniques can be used without changes and without requiring a special skill in assembly, complexity never occurs in assembling operations. Further, the lens 11 is mounted to the holding frame 13 through the retaining ring 12, and therefore, when necessity to rearrange them arises, it is recommended to detach the lens 11 to which the retaining ring 12 is attached from the holding frame 13, then attach the retaining ring 12 to the corresponding lens 11, and attach it into the holding frame 13. That is, it has been conventionally difficult to rearrange a lens after the lens is mounted into a holding frame once,

but, according to the aforementioned embodiment, the lens can be easily rearranged without causing any problems.

[0022] In the structure of Fig. 1, it is preferable to fit the lens 11 and the retaining ring 12 together not in a loose state but in a fastened state, and it is permissible to bond the lens 11 and the retaining ring 12 together with an adhesive or pressedly fit it to such an extent that the lens 11 is not distorted. Preferably, the lens 11 and the retaining ring 12 that have been united in the above-mentioned manner are pressedly fitted into the holding frame 13 by use of the elastic deformation of the retaining ring 12 so as not to cause a saccadic movement. In this case, in consideration of the expansion and shrinkage caused by the heat of the lens 11, they are pressedly fitted with an allowance so that the expansion and shrinkage can be permitted.

[0023] Next, another embodiment will be described with reference to Fig. 3 and Fig. 4.

[0024] As in the embodiment shown in Fig. 1 and Fig. 2, the retaining ring 12 and the holding frame 13 are provided for the lens 11, and the flange part 13a and the lens retainer 14 are provided in the thrust direction of the lens 11 in this embodiment.

[0025] Herein, in the embodiment shown in Fig. 1 and Fig. 2,

the first gap 16 between the lens 11 and the retaining ring 12 is generated by the concave part 19 formed at the outer periphery of the lens 11, but, in the embodiment of Fig. 2, the first gap 16 is generated by forming a concave part 23 at a corresponding part of the inner periphery of the retaining ring 12 without forming the concave part 19 in the lens 11. That is, in an arrangement relationship in which the second joint part 20 to the holding frame 13 that is provided outside is positioned at the center in the lengthwise direction along the circumferential direction, the first gap 16 is generated by forming the concave part 23 that has a fully greater length in the circumferential direction than the second joint part 20.

[0026] Also in a case where the gap is formed in this way, the second gap 21 situated outside and the first gap 16 situated inside are partially overlapped with each other, and therefore elastic deformation can be made in this overlapped part. That is, when the lens 11 is expanded, the overlapped part is elastically deformed in the direction of the second gap 21, with the second joint part 20 as a fulcrum. Therefore, stress caused by thermal deformation is absorbed by this elastic deformation, and distortion never occurs in the lens 11.

[0027] Next, still another embodiment will be described with

reference to Fig. 5 and Fig. 6.

[0028] As in the embodiment of Fig. 1 and Fig. 2, the retaining ring 12 and the holding frame 13 are provided to the lens 11, and the flange part 13a of the holding frame 13 and the lens retainer 14 are provided in this embodiment.

[0029] What is different from the embodiment shown in Fig. 1 and Fig. 2 is the structure of the second joint part 20 formed between the outer periphery of the retaining ring 12 and the inner periphery of the holding frame 13. That is, with regard to the second joint part 20, in the embodiment shown in Fig. 1 and Fig. 2, a predetermined part of the outer periphery of the retaining ring 12 is formed by protruding, and this part is used as the second joint part 20, but, in the embodiment shown in Fig. 5 and Fig. 6, the second joint part 20 is generated by protruding to form a predetermined part of the inner periphery of the holding frame 13, not by protruding to form the outer periphery of the retaining ring 12. That is, the second joint part 20 is formed by protruding an inner peripheral part of the holding frame 13 that faces a center part in the circumferential direction of the first gap 16 formed inside. The inner periphery of the holding frame 13 other than the second joint part 20 forms the first gap 16 together with the outer periphery of the retaining ring 12.

[0030] Since an overlapped part is generated between the outer second gap 21 and the inner first gap 16 also in a case in which the gap is generated in this way, this overlapped part is elastically deformed in the direction of the outer second gap 21 with the second joint part 20 as a fulcrum, and stress caused by thermal deformation is absorbed, for example, when the lens 11 is expanded. Therefore, distortion never occurs in the lens 11.

[0031] Next, still another embodiment will be described with reference to Fig. 7 and Fig. 8.

[0032] In this embodiment, the first gap 16 between the lens 11 and the retaining ring 12 is generated by the concave part 23 formed at the outer periphery of the retaining ring 12, as in the embodiment shown in Fig. 3 and Fig. 4. Further, the second gap 21 between the outer periphery of the retaining ring 12 and the inner periphery of the holding frame 13 is generated by protruding to form a predetermined part of the inner periphery of the holding frame 13 and by using this as the second joint part 20, as in the embodiment shown in Fig. 5 and Fig. 6. The second joint part 20 is formed at a part that faces a center part along the circumferential direction of the first gap 16 formed inside.

[0033] Also in this case, an overlapped part is generated

between the outer second gap 21 and the inner first gap 16, and, when the lens 11 is expanded, this overlapped part is elastically deformed in the direction of the outer second gap 21 with the second joint part 20 as a fulcrum, and stress caused by thermal deformation is absorbed. Therefore, distortion never occurs in the lens 11.

[0034] Herein, in the embodiments shown in Fig. 1, Fig. 2, Fig. 5, and Fig. 6, the concave part 19 is formed at the outer periphery of the lens 11 in order to obtain the first gap 16, but, in the embodiments shown in Fig. 3, Fig. 4, Fig. 7, and Fig. 8, there is no need to form the concave part 19 in the lens 11, and therefore the lens 11 can be easily molded, and production costs can be kept low. Additionally, since a structure as in the aforementioned embodiments can be formed by attaching the retaining ring 12 also to an existing plastic lens, costs can be greatly reduced, and the plastic lens can be used in common.

[0035] In each embodiment of Fig. 3, Fig. 4, Fig. 5, Fig. 6, Fig. 7, and Fig. 8, it is preferable to fit the lens 11 and the retaining ring 12 together, and it is permissible to bond the lens 11 and the retaining ring 12 together with an adhesive and pressedly fit it into the retaining ring 12 to such an extent that the lens 11 is not distorted. Further, in a case in which

the lens 11 and the retaining ring 12 that have been united are pressedly fitted into the holding frame 13 by use of the elastic deformation of the retaining ring 12, in consideration of the expansion and shrinkage caused by the heat of the lens 11, they are formed with an allowance so that the expansion and shrinkage can be permitted.

[0036] Additionally, in each embodiment mentioned above, the lens 11 is supported in the thrust direction by clamping the collar part 11b of the lens 11 from above and below by the flange part 13a of the holding frame 13 and by the lens retainer 14 together with the retaining ring 12 attached to the outer periphery thereof. However, if the lens 11 and the retaining ring 12 are firmly attached to each other with an adhesive or the like, only the part of the retaining ring 12 may be clamped as shown in Fig. 9.

[0037] Herein, if the lens 11 is thin, thermal expansion in the thrust direction thereof is small, and optical distortion is negligible. Therefore, in this case, no problem arises even if the collar part 11b is also clamped from above and below together with the retaining ring 12 as shown in Fig. 1 to Fig. 8. However, if the lens 11 is thick, the quantity of thermal expansion by heat increases, and, when the collar part 11b is clamped from above and below as mentioned above, optical

distortion caused by the expansion cannot be disregarded. In this case, if a structure is formed such that only the retaining ring 12 is clamped from above and below as shown in Fig. 5, and the collar part 11b of the lens 11 is not clamped from above and below, optical distortion will hardly occur, and an adverse influence caused by thermal deformation can be removed even if thermal expansion occurs in the thrust direction.

[0038]

[Effects of the Invention] According to the lens holding structural body of the present invention, there are provided the first joint part and the first gap formed between the outer periphery of the lens and the retaining ring and the second gap and the second joint part formed between the outer periphery of the retaining ring and the inner periphery of the holding frame. Therefore, lenses can be easily rearranged, and, since the occurrence of distortion is prevented by absorbing the deformation of a lens caused by heat, stable optical performance with high accuracy can be obtained.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1] Front sectional view showing one embodiment of the lens holding structural body of the present invention.

[Fig. 2] Longitudinal sectional view of the same.

[Fig. 3] Front sectional view showing another embodiment of

the same.

[Fig. 4] Longitudinal sectional view of the same.

[Fig. 5] Front sectional view showing still another embodiment of the same.

[Fig. 6] Longitudinal sectional view of the same.

[Fig. 7] Front sectional view showing still another embodiment of the same.

[Fig. 8] Longitudinal sectional view of the same.

[Fig. 9] Front sectional view showing still another embodiment of the same.

[Description of Symbols]

11 Lens

12 Retaining ring

13 Holding frame

16 First gap

17 First joint part

20 Second joint part

21 Second gap

Fig.1

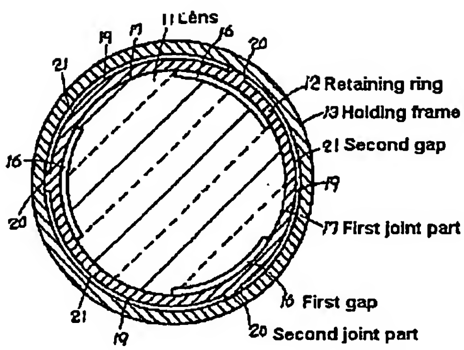

Fig.2

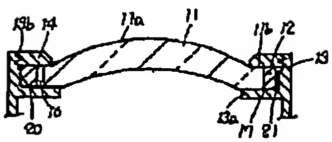

Fig.3

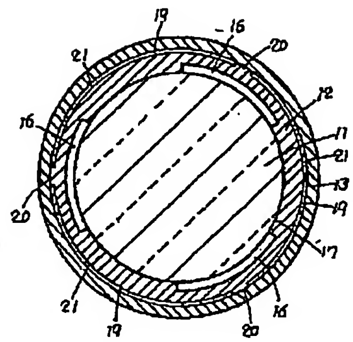

Fig.4

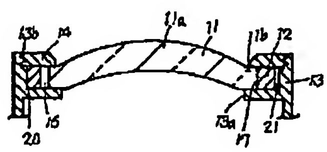

Fig.5

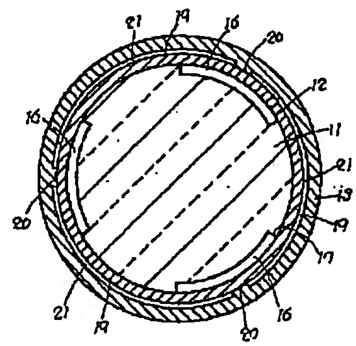

Fig.6

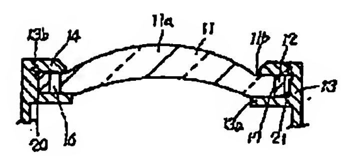

Fig.8

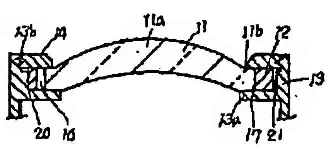

Fig.9

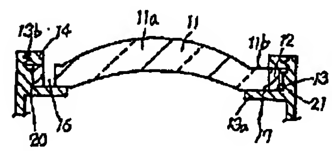

Fig.7